SPINNING PERFORMANCE AND YARN QUALITY AS INFLUENCED BY HARVESTING, GINNING, AND MILL-PROCESSING METHODS

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CONTENTS

	Page
Abstract	1
Introduction	1
Methods and materials	2
Production and harvesting	2
Ginning	2
Mill processing	2
Testing	3
Results and discussion	4
'Stoneville 213', combined harvest methods	5
'Acala 1517–V', machine-picked cotton	8
Summary and conclusions	10
Appendix.—Additional effects of test variables	12

TABLES

1.	Effect of test variables on card-room dust levels, two sampling methods	4
2.	Effect of test variables on neps in card web and ends down in spinning, 'Stoneville 213' cotton	5
3.	Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems, 'Stoneville 213' cotton	6
4.	Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems 'Stoneville 213' cotton	6
5.	Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems, 'Stoneville 213' cotton	7
6.	Effect of test variables on neps in card web and ends down in spinning, 'Acala 1517–V' machine-picked cotton	8
7.	Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems, 'Acala 1517–V' machine-picked cotton	9
8.	Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems, 'Acala 1517–V' machine-picked cotton	9
9.	Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems, 'Acala 1517–V' machine-picked cotton	11
A–1.	Effect of test variables on lint moisture and nonlint content of test cottons	12
A–2.	Effect of test variables on composite grade index	13
A–3.	Effect of test variables on total nonlint in picker lap	13
A–4.	Effect of test variables on waste removed in mill processing	14
A–5.	Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems, 'Stoneville 213' brush-stripped cotton	14
A–6.	Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems, 'Stoneville 213' brush-stripped cotton	15
A–7.	Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems, 'Stoneville 213' brush-stripped cotton	15
A–8.	Effect of test variables on neps in card web and ends down in spinning, 'Stoneville 213' brush-stripped cotton	16
A–9.	Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems, 'Stoneville 213' machine-picked cotton	16
A–10.	Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems, 'Stoneville 213' machine-picked cotton	

Page

A–11. Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems, 'Stoneville 213' machine-picked cotton 17
A–12. Effect of test variables on neps in card web and ends down in spinning, 'Stoneville 213' machine-picked cotton 18
A–13. Effect of test variables on colorimeter results, 'Stoneville 213' brush-stripped cotton 18
A–14. Effect of test variables on digital fibrograph results, 'Stoneville 213' brush-stripped cotton 19
A–15. Effect of test variables on Pressley strength and micronaire results, 'Stoneville 213' brush-stripped cotton 19
A–16. Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability), 'Stoneville 213' brush-stripped cotton 20
A–17. Effect of test variables on Suter-Webb array results (fiber lengths), 'Stoneville 213' brush-stripped cotton 20
A–18. Effect of test variables on colorimeter results, 'Stoneville 213' machine-picked cotton 21
A–19. Effect of test variables on digital fibrograph results, 'Stoneville 213' machine-picked cotton 21
A–20. Effect of test variables on Pressley strength and micronaire results, 'Stoneville 213' machine-picked cotton 22
A–21. Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability), 'Stoneville 213' machine-picked cotton 22
A–22. Effect of test variables on Suter-Webb array results (fiber lengths), 'Stoneville 213' machine-picked cotton 23
A–23. Effect of test variables on colorimeter results, 'Acala 1517–V' machine-picked cotton 23
A–24. Effect of test variables on digital fibrograph results, 'Acala 1517–V' machine-picked cotton 24
A–25. Effect of test variables on Pressley strength and micronaire results, 'Acala 1517–V' machine-picked cotton 24
A–26. Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability), 'Acala 1517–V' machine-picked cotton 25
A–27. Effect of test variables on Suter-Webb array results (fiber lengths), 'Acala 1517–V' machine-picked cotton 25

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SPINNING PERFORMANCE AND YARN QUALITY AS INFLUENCED BY HARVESTING, GINNING, AND MILL-PROCESSING METHODS

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ABSTRACT

Cottons grown in the Mississippi Delta and in New Mexico were processed through the facilities of the Cotton Quality Research Station, Clemson University, Clemson, S.C., to determine the influence of harvesting, ginning, and mill-processing methods on ring and open-end spinning performance and on the quality of yarn produced by each system. The data presented will enable processors to determine those mill-processing parameters that will contribute to optimum processing performance and yarn quality for each spinning system. **KEYWORDS: cotton, cotton ginning, cotton harvesting, mill processing (cotton), mill-processing performance (cotton), open-end spinning, ring spinning, yarn quality.**

INTRODUCTION

Dynamic changes in the production, harvesting, and processing of cotton require continuous evaluation of spinning performance and yarn quality, so that cotton can maintain its competitive position in the fiber market. Many of these changes have been the result of significant increases in production and processing costs, influenced both directly and indirectly by limited or unavailable supplies of labor and energy. Regulations such as those limiting or prohibiting the use of certain insecticides or herbicides, or limiting employee exposure to dust, noise, and other health hazards, not only have added to the cost but also have dictated a change in production and processing methods. Producers and processors must provide a work area free of hazards and maintain the quality of the environment.

New varieties with high-yield potential or an attribute that improves the market potential of cotton are continually being introduced to help the producer offset increased costs. Many of these changes influence gin and mill-processing requirements as well as fiber and yarn quality. The number, type, and sequence of processing machinery both in the gin and in the mill influence the dust content and, hence, the degree of control necessary to maintain levels within prescribed limits. Introduction of open-end spinning has necessitated a reevaluation of gin and mill processing to determine if and how each process or machine affects open-end spinning, compared to ring spinning.

With ever-changing conditions confronting the cotton industry, the effect of these changes must be reflected in current research. The objective of this experiment was to determine for two cotton varieties the influence of harvesting, ginning, and mill-processing methods on spinning performance and yarn quality of yarn spun on both the ring and open-end spinning systems.

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METHODS AND MATERIALS

Production and Harvesting

Test cotton was obtained from the Mississippi Delta and from the Rio Grande Valley in New Mexico. 'Stoneville 213' was grown at the Delta Branch Experiment Station, Stoneville, Miss., according to cultural practices recommended for the area. Fields were of the same soil type and fertility, yielding approximately 875 pounds of lint per acre.

Two harvest methods were used. One-half of the cotton was defoliated and harvested before frost using two spindle-type pickers in a once-over operation on October 25, 1974. The remaining one-half was harvested by brush stripper after frost between November 1 and December 3, 1974. The prolonged harvest period was a result of constant rains that prevented operation of the stripper except for short periods.

'Acala 1517–V' was grown by a private producer near Las Cruces, N. Mex., according to cultural practices recommended for the area. No harvest-aid chemicals were applied. All cotton was first-harvest machine-picked after frost on November 24, 1974. Three spindle-type pickers were used, all dumping into the same trailers. The field was uniform at the time of harvest.

Ginning

The 'Stoneville 213' was ginned at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss. Ginning variables for the two harvest methods were drying level and lint cleaning. The three drying levels were (1) no drying, (2) one stage of drying at 250° F, and (3) two stages of drying at 250° F. The three lint-cleaning levels were none, one, or two stages of saw-type lint cleaning. Each treatment combination was replicated 3 times, producing a total of 54 treatment combinations in the gin.

Both harvest methods were processed through a standard processing sequence for machine-picked cotton, consisting of a feed control, a tower drier, a six-cylinder cleaner, a green-leaf and stick machine, a tower drier, a six-cylinder cleaner, an extractor-feeder, and a gin stand. Drying levels were obtained by processing the cotton through the driers with no heat or through either one or two driers at 250° F. Lint-cleaning levels were obtained by bypassing the lint-cleaning system or using either one or two stages of saw-type lint cleaners.

All three replications of the machine-picked cotton were ginned on October 29, 1974. Two replications of the brush-stripped cotton were ginned on November 19, 1974, and the third replication was ginned on December 5, 1974.

The 'Acala 1517–V' was ginned at the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N. Mex. Ginning variables were seed-cotton cleaning and lint cleaning. One-half of all lots bypassed the seed-cotton-cleaning system, going directly from the drier to the extractor-feeder. All other lots went from the drier through a six-cylinder cleaner, a green-leaf and stick machine, a six-cylinder cleaner, and a third six-cylinder cleaner to the extractor-feeder. Wagon seed-cotton moisture averaged 7.5 percent, indicating that satisfactory gin processing should be achieved without drying. The three lint-cleaning levels were none, one, or two stages of saw-type lint cleaning. Each treatment combination was replicated 3 times, producing a total of 18 treatment combinations in the gin. The 'Acala 1517–V' was ginned December 5–9, 1974.

Seed cotton, seed, and lint samples were extracted during processing at both ginning laboratories for analysis for moisture and trash.

A sufficient quantity of seed cotton was used for each gin-treatment combination to produce a bale of lint weighing about 300 pounds.

At both ginning locations, treatments were randomized within replications.

Mill Processing

Mill processing was performed at the USDA Cotton Quality Research Station, Clemson University, Clemson, S.C., in three phases. The machine-picked cotton from New Mexico was used in phase I, brush-stripped cotton from Stoneville in phase II, and machine-picked cotton from Stoneville in phase III.

Each bale of cotton was divided equally for maximum and minimum mill cleaning. Maximum mill cleaning included the vertical opener and a No. 12 lattice opener. Cotton getting minimum mill cleaning bypassed these cleaners, going directly from the blender-feeders to the picker.

The 'Acala 1517–V' was combed and most of

each lot spun into 60s yarn on the ring spinning system. Most of the 'Stoneville 213' was spun into 40s yarn on the ring system. The remaining part of each lot was spun into 18s yarn on the open-end spinning system. This amount was enough cotton to operate the open-end spinning system for approximately 30 minutes and provide yarn for quality tests. On the ring system, ends-down tests of 5,020 spindle-hours were conducted for the 60s yarn, and 3,765 spindle-hours for the 40s yarn.

The processing parameters were:

Picking	One process, 14-oz laps.
Combed phase	*Carded phase*
CARDING	
20 pounds per hour	20 pounds per hour.
55-grain sliver	50-grain sliver.
BREAKER DRAWING	
42-grain sliver	53-grain sliver.
8 ends up	8 ends up.
LAP WINDING	
806 grains per lap	
20 ends up	
COMBING	
53-grain sliver	
Noils removed, 14%	
FINISHER DRAWING	
55-grain sliver	55-grain sliver.
8 ends up	8 ends up.
ROVING	
1.50 hank	1.00 hank.
1.20 twist multiplier	1.30 twist multiplier.
RING SPINNING	
60s yarn	40s yarn.
3.10 twist multiplier	3.89 twist multiplier.
13,000-r/min spindle speed	12,000-r/min spindle speed.
OPEN-END SPINNING	
18s yarn	18s yarn.
5.00 twist multiplier	5.00 twist multiplier.
45,000-r/min rotor speed	45,000-r/min rotor speed.

Testing

Yarn evaluation

For each spinning test, 1 measurement of skein strength and yarn size was made on each of 40 bobbins from the ring spinning frames, and 2 measurements were made from each of 20 tubes from the open-end spinning frame.

Sixteen bobbins were tested for yarn evenness and imperfections for each yarn type. The sensitivity of the evenness tester was set at 30 percent for thin places and at setting number 4 for thick places and neps. Yarn from each bobbin was tested at 25 yards per minute for 5 minutes (2,000 yard/lot). Imperfections are reported per 1,000 yards.

Ten single-strand-strength measurements were made on each of 40 bobbins of ring-spun yarn, and 20 measurements were made from each of 20 tubes of open-end yarn.

Yarn grade was determined from three yarn boards per spinning test by three technicians for each yarn type.

Fiber testing

Fibrograph, Pressley 0-inch gage and ⅛-inch gage (grams per tex), and micronaire fineness measurements were made on four subsamples of ginned lint from each bale, and one sample of finisher drawing sliver from each lot. Array tests were made on a composite sample from the four subsamples and on finisher drawing sliver. Shirley analyzer tests were made to determine nonlint content by means of two 100-gram samples of ginned lint from the bale.

Color measurements were made on ginned-lint samples before and after Shirley analyzer tests.

Official classification data were obtained from the Board of Supervisory Cotton Examiners, Memphis, Tenn.

The resulting measurements can be summed up as follows:

Instrument	Measurements per sample	Number of samples	Total measurements per bale or lot
330 fibrograph (Fibrosampler)	4	5	20
Array	2	2	4
Pressley:			
0-in Gage	4	5	20
⅛-in Gage	4	5	20
Micronaire	2	5	10

Card-room dust levels

Dust levels were determined from dust samples extracted while processing the test cotton through the experimental card room. Standard processing conditions and procedures were maintained for all lots, and dust samples were obtained with both a personal sampler and a vertical elutriator sampler. Measurements were made at four locations within the card room with the personal sampler and at two locations with the elutriator sampler.

Chemical analysis for noncellulosic constituents

Chemical analyses were performed on finisher drawing sliver to test for uniformity of stock. Sugar content was determined by comparing the reducing ability of the water extract of the cotton to that of a standard reducing sugar, glucose. Wax content and alcohol extractables were determined by soxhlet extractions using benzine and ethyl alcohol, respectively. Hydrocarbon oil contamination was determined by means of hexane in a room temperature extraction procedure.

Statistical analysis

An analysis of variance, in conjunction with Duncan's new multiple-range test, was used to determine statistical significance of the differences between the treatment levels of moisture and trash at the gin for each of the three combinations of varieties and harvest method. The design was a randomized complete block involving a factorial arrangement.

A randomized complete block involving a factorial treatment arrangement was also used to analyze mill-processing and yarn-quality data. Variables for each 'Stoneville 213' harvest method were three drying levels, three lint-cleaning levels, and two mill-cleaning levels with three replications. Data for the two 'Stoneville 213' harvest methods were also combined for analysis to determine the effect of harvest method on treatment means.

Variables for the 'Acala 1517–V' were two seed-cotton cleaning levels, three lint-cleaning levels, and two mill-cleaning levels with three replications.

RESULTS AND DISCUSSION

The effects of test variables on lint moisture, total nonlint content in the bale, composite grade index, total nonlint content in the picker lap, and waste removed in mill processing are shown in tables A–1 to A–4 (appendix). Lint moisture decreased as more driers were used when seed cotton was processed through the overhead cleaning system. Nonlint content in the bale de-

TABLE 1.—*Effect of test variables on card-room dust levels, two sampling methods*

[Milligrams per cubic meter]

Test variable	Personal sampler			Vertical elutriator sampler		
	'Stoneville 213'		'Acala 1517–V', machine-picked	'Stoneville 213'		'Acala 1517–V', machine-picked
	Brush-stripped	Machine-picked		Brush-stripped	Machine-picked	
Replication:[1]						
1	4.83	3.14a	5.06ab	4.33	2.95	4.25ab
2	4.98	3.28a	5.59a	4.41	3.08	4.84a
3	4.81	3.65b	4.07b	4.37	3.09	3.64b
Number of driers:[1]						
0	5.54a	3.57a	([2])	4.90a	3.17a	([2])
1	4.64b	3.54a	([2])	4.18b	3.17a	([2])
2	4.44b	3.06b	([2])	4.03b	2.77b	([2])
Seed-cotton-cleaning level:						
Bypass overhead	([2])	([2])	5.05	([2])	([2])	4.31
Through overhead	([2])	([2])	4.76	([2])	([2])	4.19
Number of lint cleaners:						
0	[3]5.54a	[3]3.79a	[3]5.17a	[3]5.00a	[3]3.45a	4.35
1	4.78b	3.20b	5.26a	4.26b	2.93b	4.58
2	4.30c	3.08b	4.30b	3.85b	2.73b	3.81
Mill-cleaning level:						
Minimum[4]	[3]5.14a	[3]3.57a	[3]5.43a	[3]4.62a	[3]3.23a	[3]4.58a
Maximum[5]	4.60b	3.15b	4.39b	4.12b	2.85b	3.91b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Not a test variable for this cotton.
[3] Means not having a letter in common are significantly different at the 5% level.
[4] Cotton bypassed the vertical and lattice openers, going directly from the blender-feeders to the picker.
[5] Cotton processed through the entire opening-picking line: 3 blender-feeders, a vertical opener, a No. 12 lattice opener, and a 2-section 1-process picker.

creased with increased drying and lint cleaning and when seed cotton was processed through the overhead system. The decrease in nonlint content was reflected in improved grade indices.

Opening and picking waste was significantly higher when lint cleaners were bypassed in the gin and when the maximum level of mill cleaning was used. However, nonlint content in the picker lap still showed the effect of drying, lint cleaning, and mill-cleaning levels. Nonlint content decreased as more driers and lint cleaners were used and as the level of mill cleaning was increased to the maximum.

Spinning data for the 'Stoneville 213' brush-stripped cotton are shown in tables A–5 to A–8, and for the 'Stoneville 213' machine-picked cotton in tables A–9 to A–12.

Spinning results are discussed below under two major headings: (1) "'Stoneville 213', Combined Harvest Methods," and (2) "'Acala 1517–V', Machine-Picked Cotton."

Colorimeter, digital fibrograph, Pressley strength, micronaire, and Suter-Webb array results for 'Stoneville 213' brush-stripped cotton are shown in tables A–13 to A–17; for 'Stoneville 213' machine-picked cotton in tables A–18 to A–22; and for 'Acala 1517–V' machine-picked cotton in tables A–23 to A–27.

The above data are provided as additional information and, generally, will not be referred to in the discussion of test results.

Card-room dust levels were affected significantly by all test variables (table 1). Dust levels by both sampling methods decreased as drying, seed-cotton-cleaning, lint-cleaning, and mill-cleaning levels were increased.

'Stoneville 213', Combined Harvest Methods

There were more neps in the card web for the brush-stripped cotton than there were for the machine-picked cotton (table 2). The level of drying affected the number of neps in the card web, but no trend could be established, and the numerical differences appear to be of no practical significance. Neps in the card web also increased as the level of lint cleaning was increased, but again numerical differences were small.

The break factor of ring-spun and open-end-spun yarns for both harvest methods decreased as the drying level was increased. However, the break factor for the brush-stripped cotton was significantly lower than that of the machine-picked cotton at all levels of drying (table 3). For the machine-picked cotton, the decrease in break factor of both the ring-spun and open-end-spun yarns was more pronounced when the drying level was increased from no drying to one stage of drying than it was when the drying level was increased from one stage to two. For the brush-stripped cotton, the decrease in break factor of ring-spun yarn was more pronounced when the drying level was increased from one stage of drying to two.

Lint-cleaning level affected the break factor of open-end-spun yarn, but the trend was inconclusive.

Appearance index of yarn from machine-picked cotton spun on the ring system was higher than that of yarn from brush-stripped cotton. Appearance index of ring-spun yarn decreased when the second stage of drying was used and when the level of lint cleaning was increased. However, appearance index of ring-spun yarn from brush-stripped cotton responded differently to the lint-cleaning level

TABLE 2.—*Effect of test variables on neps in card web and ends down in spinning,* 'Stoneville 213' *cotton*

Test variable	Neps in card web per 100 in[2]	Ends down per 1,000 spindle-hours
Replication:[1]		
1	8	43a
2	8	49a
3	8	108b
Harvest method:[1]		
Brush-stripped	10a	113a
Machine-picked	8b	21b
Number of driers:		
0	[2]8.4a	[1]50a
1	7.6b	59a
2	7.9ab	92b
Number of lint cleaners:[1]		
0	7a	65
1	8b	64
2	9c	72
Mill-cleaning level:[3]		
Minimum	8	
Maximum	8	

[1] Means not having a letter i
cantly different at the 1% level.
[2] Means not having a letter i
cantly different at the 5% level.
[3] For explanation of minimu
table 1, notes 4 and 5.

TABLE 3.—*Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems,* 'Stoneville 213' *cotton*

Test variable	Break factor units		Yarn appearance index		Neps per 1,000 yd	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	[1]1,775a	[1]1,609a	85	129	950	[2]486a
2	1,757a	1,603ab	85	130	947	431b
3	1,710b	1,590b	86	132	958	457ab
Harvest method:						
Brush-stripped	[1]1,643a	[1]1,561a	[1]78a	130	[1]1,194a	[2]474a
Machine-picked	1,852b	1,641b	92b	131	709b	442b
Number of driers:						
0	[1]1,815a	[1]1,650a	[1]86a	129	[2]925a	454
1	1,734b	1,593b	86a	132	937a	457
2	1,694c	1,560c	84b	131	993b	464
Number of lint cleaners:						
0	1,762	[2]1,610a	[1]87a	132	[1]895a	468
1	1,733	1,593b	85b	131	949ab	443
2	1,748	1,599ab	83c	129	1,011b	465
Mill-cleaning level:[3]						
Minimum	1,748	1,601	85	132	947	[1]431a
Maximum	1,747	1,600	85	129	956	485b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE 4.—*Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *cotton*

Test variable	Strength (g)		Elongation (%)		Strength coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	[1]176a	[2]300a	4.9	5.2	11.9	8.5
2	175a	299a	4.9	5.3	12.1	8.6
3	172b	292b	4.9	5.2	12.4	8.4
Harvest method:[2]						
Brush-stripped	166a	291a	4.8a	5.1a	12.4a	8.5
Machine-picked	182b	303b	5.1b	5.3b	11.9b	8.5
Number of driers:						
0	[2]179a	[2]305a	4.9	5.2	12.1	[1]8.3a
1	173b	296b	4.9	5.2	12.0	8.7b
^	171b	291c	5.0	5.2	12.3	8.6b
of lint cleaners:						
	175	296	4.9	5.2	11.9	8.6
	173	297	4.9	5.2	12.3	8.5
2	174	298	4.9	5.2	12.2	8.4
Mill-cleaning level:[2 3]						
Minimum	175	297	4.9	5.1a	12.1	8.4
Maximum	173	297	4.9	5.3b	12.2	8.6

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

than that of yarn from the machine-picked cotton. Appearance index of yarn from brush-stripped cotton decreased uniformly as the level of lint cleaning was increased, whereas appearance index of yarn from machine-picked cotton decreased slightly when the first stage of lint cleaning was added. There was no additional response when the second stage was added.

Test variables did not affect the appearance index of yarn spun on the open-end system.

The number of neps in yarn from machine-picked cotton was less than that in yarn from brush-stripped cotton on both the ring and open-end spinning systems. The number of neps in ring-spun yarn increased as the drying level and the lint-cleaning level were increased. Neps in open-end-spun yarn were significantly greater when the maximum mill-cleaning level was used.

Strength for both ring-spun and open-end-spun yarns was higher for the machine-picked cotton than for the brush-stripped cotton, and strength of yarn from both spinning systems decreased as the level of drying was increased (table 4). When the first stage of drying was added, there was a more pronounced decrease in the strength of yarn from machine-picked cotton than there was for yarn from brush-stripped cotton.

Elongation of ring-spun and open-end-spun yarns was higher for the machine-picked cotton than for the brush-stripped cotton. Elongation of open-end yarn increased when the maximum mill-cleaning level was used. Yarn elongation was affected differently by the two methods of harvest and by the lint-cleaning level. When no lint cleaners were used, yarn elongation for both cottons was the same, but when one lint cleaner was used, yarn elongation for brush-stripped cotton decreased and that of machine-picked cotton increased. When two lint cleaners were used, there was no further change in elongation of yarn from brush-stripped cotton, but there was a decrease in that of yarn from the machine-picked cotton.

Strength coefficient of variability (c.v.) of ring-spun yarn was lower for the machine-picked cotton than it was for the brush-stripped cotton. Strength c.v. of open-end-spun yarn was lower for cotton that bypassed the lint cleaning system than it was for cotton processed through either one or two lint cleaners.

TABLE 5.—*Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *cotton*

Test variable	Thick places per 1,000 yd		Low places per 1,000 yd		Irregularity coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	[1]3,080a	287	[2]5,243a	1,718	[1]22.9a	15.2
2	3,138ab	280	5,270a	1,641	23.0a	15.1
3	3,234b	297	5,427b	1,711	23.4b	15.2
Harvest method:[1]						
Brush-stripped	3,411a	244a	5,722a	1,611a	23.7a	15.0a
Machine-picked	2,890b	332b	4,904b	1,769b	22.5b	15.3b
Number of driers:[1]						
0	2,934a	308a	4,987a	1,719	22.6a	15.2
1	3,136b	289ab	5,303b	1,680	23.1b	15.2
2	3,382c	267b	5,651c	1,671	23.6c	15.1
Number of lint cleaners:[1]						
0	3,065a	292	5,198a	1,709	22.9a	15.1
1	3,138ab	281	5,301ab	1,661	23.1ab	15.1
2	3,249b	292	5,442b	1,700	23.3b	15.2
Mill-cleaning level:[1 3]						
Minimum	3,137	270a	5,298	1,623a	23.1	15.0a
Maximum	3,164	306b	5,329	1,757b	23.2	15.2b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

For yarns spun on the ring system, there were fewer thick places in yarn from the machine-picked cotton than there were in yarn from the brush-stripped cotton. For yarns spun on the open-end system, there were more thick places in yarn from the machine-picked cotton (table 5). Low places in yarn followed the same trend. This is further confirmed in results showing ring-spun yarn from machine-picked cotton with a lower irregularity c.v. than that of the brush-stripped cotton. For open-end-spun yarns, irregularity c.v. of yarn from brush-stripped cotton was lower than that of the machine-picked cotton.

For yarn spun on the ring system, the number of thick and low places increased as the level of drying was increased, and the irregularity c.v. reflected this trend. For yarn spun on the open-end system, the number of thick places decreased as the drying level was increased. The level of drying did not affect the number of low places or irregularity c.v. of yarn spun on the open-end system.

Increasing the level of lint cleaning had an adverse effect on the number of thick and low places and irregularity c.v. of yarn spun on the ring system but had no effect on that of yarn spun on the open-end system.

Cotton processed at the maximum mill-cleaning level and spun on the open-end system had more thick and low places and a higher irregularity c.v. than the cotton processed through the minimum mill-cleaning level and spun on the open-end system. Mill-cleaning level had no effect on ring-spun yarns.

Ends down per 1,000 spindle-hours increased when the second stage of drying was added (table 2). There were more ends down per 1,000 spindle-hours for the brush-stripped cotton than for the machine picked cotton.

An increase in the drying level resulted in an increase in the number of ends down during spinning for both methods of harvest. However, the number of ends down for the machine-picked cotton was significantly lower than that of the brush-stripped cotton at all levels of drying. Ends down for the machine-picked cotton increased uniformly as the drying level was increased, whereas a significant increase in ends down was noted when the drying level for the brush-stripped cotton was increased from one stage to two.

'Acala 1517–V', Machine-Picked Cotton

There was no increase in card-web neps when the first stage of lint cleaning was added to the processing sequence, but there was a significant increase when the second stage was added (table 6).

Neither the seed-cotton-cleaning level, the lint-cleaning level, nor the mill-cleaning level had a significant effect on the break factor of ring-spun or open-end-spun yarns from 'Acala 1517–V' cotton (table 7).

The appearance indices of ring-spun and open-end-spun yarns were affected by the lint-cleaning level. For ring-spun yarn, there was no difference in the appearance index between none and one stage of lint cleaning, but there was a reduction when the second stage was added. For the open-end-spun yarn, appearance index improved when the first stage of lint cleaning was added, but there was no difference between one stage and two stages of lint cleaning. Appearance index of ring-spun yarn decreased when the maximum mill-cleaning level was used, but appearance index of open-end-spun yarn was not affected by the mill-cleaning level.

An increase in the level of seed-cotton clean-

TABLE 6.—*Effect of test variables on neps in card web and ends down in spinning, 'Acala 1517–V' machine-picked cotton*

Test variable	Neps in card web per 100 in²	Ends down per 1,000 spindle-hours
Replication:[1]		
1	8	22a
2	8	23a
3	7	32b
Seed-cotton-cleaning level:		
Bypass overhead	8	23
Through overhead	8	28
Number of lint cleaners:[2]		
0	7a	25
1	7a	24
2	9b	28
Mill-cleaning level:[3]		
Minimum	7	25
Maximum	8	26

[1] Means not having a letter in common are significantly different at the 5% level.

[2] Means not having a letter in common are significantly different at the 1% level.

[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

ing and mill cleaning resulted in an increase in the number of neps in yarn spun on the open-end system.

For yarn spun on the open-end system, there was a significant difference in the strength of yarn from cotton processed through one lint cleaner and that of cotton processed through two lint cleaners (table 8). Yarn strength decreased when two lint cleaners were used. Test variables had no effect on strength of yarn processed on the ring-spinning system. Elongation of ring-spun yarn increased when either one or two stages of lint cleaning were used, but there was no difference between the two

TABLE 7.—*Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems,* 'Acala 1517–V' *machine-picked cotton*

Test variable	Break factor units		Yarn appearance index		Neps pers 1,000 yd	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	2,328	1,960	114	134	216a	243
2	2,294	2,085	113	134	298b	236
3	2,278	2,059	116	134	290b	244
Seed-cotton-cleaning level:[1]						
Bypass overhead	2,296	1,992	114	134	281	236a
Through overhead	2,304	2,077	115	133	255	246b
Number of lint cleaners:[2]						
0	2,296	1,954	115a	132a	268	230
1	2,324	2,080	115a	136b	248	240
2	2,279	2,070	112b	134ab	289	252
Mill-cleaning level:[1 3]						
Minimum	2,291	2,070	116a	133	262	237a
Maximum	2,310	2,000	112b	134	275	244b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE 8.—*Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems,* 'Acala 1517–V' *machine-picked cotton*

Test variable	Strength (g)		Elongation (%)		Strength coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	142	400a	5.0	5.7	10.4	7.6
2	140	397ab	5.0	5.7	10.4	7.1
3	142	391b	5.0	5.7	10.2	7.4
Seed-cotton-cleaning level:[2]						
Bypass overhead	141	397	5.0	5.7	10.4	7.1a
Through overhead	141	395	5.0	5.7	10.2	7.6b
Number of lint cleaners:						
0	141	[2]397ab	[1]4.9a	5.6	10.3	7.5
1	142	399a	5.1b	5.8	10.3	7.3
2	141	392b	5.1b	5.7	10.3	7.3
Mill-cleaning level:[3]						
Minimum	142	398	5.1	[2]5.6a	10.4	[1]6.8a
Maximum	141	394	5.0	5.8b	10.3	7.9b

[1] Means not followed by a common letter are significantly different at the 1% level.
[2] Means not followed by a common letter are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

lint-cleaning levels. Elongation of open-end-spun yarn increased significantly when the maximum level of mill cleaning was used.

Strength c.v. of open-end-spun yarn increased when higher levels of seed-cotton cleaning and mill cleaning were used. Test variables had no effect on strength c.v. of yarn spun on the ring system.

The number of thick places in ring-spun yarn was influenced by the level of lint cleaning, increasing as the level of lint cleaning was increased (table 9). There was a significant difference between no lint cleaning and two lint cleaners. On the open-end system, the number of thick places was affected by the mill-cleaning level, increasing as the mill-cleaning level was increased.

The number of low places in both yarn types was not affected by the test variables.

Irregularity c.v. of ring-spun yarn was affected by the lint-cleaning level, increasing as the level of lint cleaning was increased. Irregularity c.v. of open-end-spun yarn was not affected by test variables.

Ends down per 1,000 spindle-hours were not affected by the test variables (table 6).

SUMMARY AND CONCLUSIONS

A study was conducted in 1974–75 at the Cotton Quality Research Station, Clemson, S.C., to determine the influence of harvesting, ginning, and mill-processing methods on spinning performance and yarn quality.

'Stoneville 213'.—Processing performance and quality of yarn from 'Stoneville 213' machine-picked cotton were generally superior to that of the brush-stripped cotton on both the ring and open-end spinning systems. For yarn spun on the ring system from machine-picked cotton, the break factor, appearance index, strength, and percentage of elongation were higher, and the nep count, strength c.v., number of thick and low places, and irregularity c.v. lower than that of the brush-stripped cotton. Yarn spun from machine-picked cotton on the open-end system had a higher break factor, was stronger, had a higher percentage of elongation, and fewer neps than that of yarn from the brush-stripped cotton, but the number of thick and low places and the irregularity c.v. were greater than that of the brush-stripped cotton.

The number of neps in the card web and the ends down per 1,000 spindle-hours were greater for the brush-stripped cotton than they were for the machine-picked cotton.

The spinning performance and yarn quality of the brush-stripped cotton may have been influenced somewhat by the delay in harvest because of inclement weather.

Increased drying levels generally had an adverse effect on yarn quality. For ring-spun yarn, increasing the drying level decreased the break factor, yarn appearance index, and strength, and increased the nep count, number of thick and low places in yarn, and irregularity c.v. For open-end-spun yarn, increased drying levels reduced the break factor and yarn strength and increased the strength c.v. and number of thick places in the yarn.

Increased levels of lint cleaning decreased the appearance index of ring-spun yarn and increased the nep count, number of thick and low places, and irregularity c.v. Quality of open-end-spun yarn was not affected by the level of lint cleaning.

Neps in the card web increased as the level of lint cleaning was increased.

The mill-cleaning level had no effect on the quality of yarn spun on the ring system, but for yarn spun on the open-end system with the maximum mill-cleaning level there were increases in the number of neps, the percentage of elongation, the number of thick and low places in the yarn, and the irregularity c.v.

'Acala 1517–V'.—The seed-cotton-cleaning level at the gin had no effect on 'Acala 1517–V' cotton spun on the ring system, but for yarn spun on the open-end system, the number of neps and the strength c.v. increased when the seed-cotton-cleaning system was used.

The influence of common test variables on the processing performance and quality of yarn from 'Acala 1517–V' cotton was similar to that of the 'Stoneville 213' cottons but at a different level. The appearance index of 'Acala 1517–V' yarn spun on the ring system decreased as the lint-cleaning level was increased, and the percentage of elongation, number of thick places, irregularity c.v., and neps in the card web increased as the lint-cleaning level was increased. For open-end-spun yarn, strength decreased as the lint-cleaning level was increased. The yarn

TABLE 9.—*Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems,* 'Acala 1517–V' *machine-picked cotton*

Test variable	Thick places per 1,000 yd		Low places per 1,000 yd		Irregularity coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	1,021a	278	2,648	1,307	17.6	14.8
2	944b	242	2,688	1,326	17.8	14.7
3	1,007a	248	2,566	1,297	17.7	14.7
Seed-cotton-cleaning level:						
Bypass overhead	981	255	2,643	1,286	17.7	14.6
Through overhead	1,000	258	2,625	1,333	17.7	14.7
Number of lint cleaners:						
0	[2]930a	261	2,581	1,324	[1]17.6a	14.7
1	994ab	255	2,637	1,315	17.7ab	14.7
2	1,048b	253	2,685	1,291	17.8b	14.6
Mill-cleaning level:[1 3]						
Minimum	980	243a	2,631	1,270	17.7	14.6
Maximum	1,001	269b	2,638	1,350	17.7	14.8

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

appearance index was affected by the lint-cleaning level, but the trend was inconclusive.

Increasing the level of mill cleaning had an adverse effect on the appearance index of ring-spun yarn. For open-end-spun yarn, increasing the mill-cleaning level resulted in an increase in neps, percentage of elongation, strength c.v., and the number of thick places.

Generally, the quality of ring-spun yarn was affected severely by the drying and lint-cleaning levels and little by the seed-cotton-cleaning and mill-cleaning levels. On the other hand, quality of open-end-spun yarn was affected severely by the mill-cleaning level, moderately by the drying and lint-cleaning levels, and little by the seed-cotton-cleaning level.

It should be pointed out that open-end spinning is a relatively new technology. Many processing variables and fiber properties long considered important to ring-yarn spinning are also proving, as one might suspect, to be important in the open-end yarn spinning. Although few specific, quantitative relationships involving ring-spinning-processing variables and processing quality have been developed, considerable information is available on general trends. This information contributes significantly to the interpretation of statistical and other analyses of experimental results. However, no such background of information is available for open-end spinning. In some cases, the response in spinning quality to changes in a processing variable is quite different from that expected for ring yarn. Until sufficient information is established on the relative importance of various fiber and processing variables to establish general trends, statistical results will be reported in terms of significant differences. Physical interpretation of many results will be possible only after much more thorough study of the open-end system under a wide range of fiber and processing conditions.

APPENDIX.--ADDITIONAL EFFECTS OF TEST VARIABLES

TABLE A–1.—*Effect of test variables on lint moisture and nonlint content of test cottons*

[Percent]

Test variable	Lint moisture[1]			Total nonlint content[2]		
	'Stoneville 213'		'Acala 1517–V', machine-picked	'Stoneville 213'		'Acala 1517–V', machine-picked
	Brush-stripped	Machine-picked		Brush-stripped	Machine-picked	
Replication:						
1	[3]8.00a	6.54	[4]6.31a	7.66	[3]4.72ab	4.27
2	7.40a	5.91	6.79b	7.14	4.51a	4.52
3	5.22b	5.98	6.63b	7.51	5.06b	4.68
Number of driers:						
0	[3]9.04a	[3]7.91a	([5])	[4]8.57a	[4]5.22a	([5])
1	6.72b	6.14b	([5])	7.31b	4.88a	([5])
2	4.85c	4.38c	([5])	6.42b	4.29b	([5])
Seed-cotton-cleaning level:[4]						
Bypass overhead	([5])	([5])	6.77a	([5])	([5])	4.92a
Through overhead	([5])	([5])	6.36b	([5])	([5])	4.06b
Number of lint cleaners:						
0	7.13	6.27	[3]6.57ab	[4]11.22a	[4]6.69a	[4]7.73a
1	6.79	6.20	6.39a	6.04b	4.41b	3.60b
2	6.70	5.97	6.74b	5.04b	3.19c	2.13c

[1] All 'Stoneville 213' samples taken from lint slide. 'Acala 1517–V' samples taken from lint slide when no lint cleaning used, otherwise samples taken from 1st lint cleaner condenser.

[2] Determined by Shirley analyzer, ASTM D 2812–70. Samples extracted from bale in opening room.

[3] Means not having a letter in common are significantly different at the 5% level.

[4] Means not having a letter in common are significantly different at the 1% level.

[5] Not a test variable for this cotton.

TABLE A–2.—*Effect of test variables on composite grade index*[1]

Test variable	'Stoneville 213'		'Acala 1517–V', machine-picked
	Brush-stripped[2]	Machine-picked	
Replication:[3]			
1	74.3a	87.7	87.2
2	74.3a	89.4	86.7
3	77.0b	90.8	86.7
Number of driers:[4]			
0	72.7a	87.2a	([5])
1	75.0b	88.4ab	([5])
2	78.0c	92.2b	([5])
Seed-cotton-cleaning level:			
Bypass overhead	([5])	([5])	87.0
Through overhead	([5])	([5])	86.7
Number of lint cleaners:[4]			
0	70.0a	82.9a	77.7a
1	75.7b	90.8b	88.3b
2	80.0c	94.2b	94.5c

[1] Index: Middling White (31) = 100; SLM (41) = 94; LM (51) = 85; SGO (61) = 76; GO (71) = 70.

[2] Most of these grades were reduced because of grass or bark.

[3] Means not having a letter in common are significantly different at the 5% level.

[4] Means not having a letter in common are significantly different at the 1% level.

[5] Not a test variable for this cotton.

TABLE A–3.—*Effect of test variables on total nonlint in picker lap*[1]

[Percent]

Test variable	'Stoneville 213'		'Acala 1517–V', machine-picked[2]
	Brush-stripped	Machine-picked	
Replication:[3]			
1	6.81	3.57	3.03a
2	6.95	3.26	3.51b
3	6.62	3.36	...
Number of driers:[4]			
0	8.17a	3.97a	([5])
1	6.46b	3.36b	([5])
2	5.74c	2.87c	([5])
Seed-cotton-cleaning level:			
Bypass overhead	([5])	([5])	3.22
Through overhead	([5])	([5])	3.32
Number of lint cleaners:[4]			
0	9.02a	4.33a	4.22a
1	6.14b	3.33b	2.94b
2	5.21c	2.54c	2.65b
Mill-cleaning level:[6]			
Minimum	[4]7.14a	[3]3.59a	[4]3.58a
Maximum	6.44b	3.21b	2.96b

[1] Determined by Shirley analyzer, ASTM D 2812–70.

[2] Data in this column are for 2 replications only.

[3] Means not having a letter in common are significantly different at the 5% level.

[4] Means not having a letter in common are significantly different at the 1% level.

[5] Not a test variable for this cotton.

[6] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–4.—*Effect of test variables on waste removed in mill processing*

[Percent]

Test variable	Opening and picking waste			Card waste		
	'Stoneville 213'		'Acala 1517–V', machine-picked	'Stoneville 213'		'Acala 1517–V', machine-picked
	Brush-stripped	Machine-picked		Brush-stripped	Machine-picked	
Replication:[1]						
1	2.10	1.23	1.23	7.00	3.96	2.89a
2	2.35	1.12	1.33	7.34	3.77	3.00ab
3	2.06	1.19	1.49	7.02	3.88	3.22b
Numbers of driers:[2]						
0	2.41	1.28	([3])	8.20a	4.34a	([3])
1	2.15	1.18	([3])	6.88b	3.88ab	([3])
2	1.95	1.08	([3])	6.27c	3.39b	([3])
Seed-cotton-cleaning level:[1]						
Bypass overhead	([3])	([3])	1.51a	([3])	([3])	3.16a
Through overhead	([3])	([3])	1.19b	([3])	([3])	2.91b
Number of lint cleaners:[2]						
0	4.13a	2.02a	2.54a	9.60a	5.01a	4.22a
1	1.40b	.88b	.91b	6.41b	3.62b	2.69b
2	.99b	.64b	.59b	5.34c	2.98c	2.21c
Mill-cleaning level:[2] [4]						
Minimum	1.14a	.57a	.71a	7.62a	4.05	3.33a
Maximum	3.20b	1.79b	1.99b	6.61b	3.69	2.74b

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.
[3] Not a test variable for this cotton.
[4] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–5.—*Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Break factor units		Yarn appearance index		Neps per 1,000 yd	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	1,691a	1,572a	79	129	1,122a	487
2	1,673a	1,574a	78	130	1,153a	450
3	1,566b	1,537b	77	131	1,307b	487
Number of driers:						
0	[1]1,686a	[1]1,598a	[1]79a	131	[2]1,196ab	476
1	1,658a	1,561b	79a	130	1,165b	464
2	1,585b	1,524c	76b	130	1,221a	488
Number of lint cleaners:[1]						
0	1,648	1,568	[1]81a	130	[1]1,138a	472
1	1,636	1,557	78b	130	1,192a	474
2	1,646	1,558	75b	130	1,252b	477
Mill-cleaning level:[2] [3]						
Minimum	1,640	1,564	78	131	1,196	454a
Maximum	1,647	1,558	78	129	1,192	495b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–6.—*Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Strength (g)		Elongation (%)		Strength coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	170a	296a	4.7	5.0	12.9a	8.5
2	170a	294a	4.8	5.1	12.3b	8.6
3	160b	284b	4.8	5.2	12.9a	8.5
Number of driers:[1]						
0	170a	296a	4.7	5.1	12.4	8.4
1	167a	291ab	4.8	5.1	12.2	8.6
2	162b	286b	4.8	5.1	12.6	8.6
Number of lint cleaners:[2]						
0	167	291	4.8a	5.2	12.4	8.6
1	165	291	4.7b	5.1	12.5	8.6
2	167	292	4.8a	5.1	12.3	8.4
Mill-cleaning level:[3]						
Minimum	167	292	4.8	5.1	12.4	8.4
Maximum	166	290	4.7	5.2	12.3	8.7

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–7.—*Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Thick places per 1,000 yd		Low places per 1,000 yd		Irregularity coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	[1]3,244a	[2]262a	[1]5,485a	1,643	[1]23.3a	15.1
2	3,307a	237ab	5,553a	1,566	23.4a	14.9
3	3,682b	234b	6,130b	1,624	24.4b	15.0
Number of driers:[1]						
0	3,237a	255	5,438a	1,645	[1]23.3a	15.1
1	3,349a	251	5,652b	1,577	23.5a	15.0
2	3,646b	227	6,078c	1,611	24.3b	15.0
Number of lint cleaners:						
0	[1]3,330a	243	5,626	1,614	[2]23.6a	15.0
1	3,415ab	232	5,751	1,588	23.7ab	15.0
2	3,488b	257	5,790	1,632	23.9b	15.1
Mill-cleaning level:[3]						
Minimum	3,393	[2]231a	5,695	[2]1,551a	23.7	[1]14.9a
Maximum	3,429	257b	5,750	1,672b	23.7	15.1b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–8.—*Effect of test variables on neps in card web and ends down in spinning,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Neps in card web per 100 in²	Ends down per 1,000 spindle-hours
Replication:[1]		
1	10	67a
2	9	75a
3	10	196b
Number of driers:[1]		
0	10	86a
1	10	96a
2	10	156b
Number of lint cleaners:[1]		
0	9a	107
1	10b	110
2	11c	121
Mill-cleaning level:[2]		
Minimum	10	114
Maximum	10	111

[1] Means not having a letter in common are significantly different at the 1% level.

[2] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–9.—*Effect of test variables on break factor, yarn appearance, and neps of yarn spun on two systems,* 'Stoneville 213' *machine-picked cotton*

Test variable	Break factor units		Yarn appearance index		Neps per 1,000 yd	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	1,859	1,646	[1]91a	129	[1]778a	[2]485a
2	1,842	1,632	92a	131	741a	412b
3	1,855	1,643	94b	133	609b	428b
Number of driers:						
0	[1]1,944a	[1]1,702a	[2]93a	127	[1]654a	431
1	1,809b	1,623b	93a	134	709ab	450
2	1,802b	1,596c	91b	131	766b	445
Number of lint cleaners:						
0	[2]1,876a	[2]1,653a	93	134	[1]652a	461
1	1,829b	1,629b	92	132	706ab	412
2	1,851b	1,639ab	92	127	770b	452
Mill-cleaning level:[1] [3]						
Minimum	1,857	1,638	93	133	699	409a
Maximum	1,847	1,643	92	128	720	475b

[1] Means not having a letter in common are significantly different at the 1% level.

[2] Means not having a letter in common are significantly different at the 5% level.

[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–10.—*Effect of test variables on strength, elongation, and strength coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *machine-picked cotton*

Test variable	Strength (g)		Elongation (%)		Strength coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:[1]						
1	181	303ab	5.1	5.3	12.0	8.5
2	181	305a	5.1	5.4	11.9	8.7
3	184	300b	5.1	5.3	11.8	8.3
Number of driers:[2]						
0	187a	314a	5.0	5.3	11.8	8.2
1	179b	300b	5.0	5.2	11.9	8.7
2	179b	295b	5.1	5.3	12.0	8.6
Number of lint cleaners:[1]						
0	182	301	5.1	5.2	11.5a	8.6
1	181	304	5.1	5.4	12.0b	8.5
2	181	304	5.0	5.3	12.2b	8.4
Mill-cleaning level:[3]						
Minimum	183	302	5.1	5.2	11.7	8.4
Maximum	181	303	5.1	5.4	12.0	8.6

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–11.—*Effect of test variables on thick places, low places, and irregularity coefficient of variability of yarn spun on two systems,* 'Stoneville 213' *machine-picked cotton*

Test variable	Thick places per 1,000 yd		Low places per 1,000 yd		Irregularity coefficient of variability (%)	
	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning	Ring spinning	Open-end spinning
Replication:						
1	[1]2,915a	[1]312a	[1]5,002a	1,792	[2]22.4a	15.2
2	2,969a	324a	4,987a	1,716	22.7b	15.3
3	2,787b	360b	4,725b	1,798	22.5a	15.3
Number of driers:[1]						
0	2,631a	362a	4,537a	1,793	21.9a	15.3
1	2,923b	326b	4,953b	1,782	22.6b	15.3
2	3,117c	308b	5,224c	1,731	23.0c	15.2
Number of lint cleaners:[1]						
0	2,799a	340	4,769a	1,805	22.3a	15.3
1	2,861a	329	4,851a	1,733	22.6ab	15.3
2	3,010b	327	5,094b	1,769	22.8b	15.2
Mill-cleaning level:[1 3]						
Minimum	2,881	308a	4,901	1,696a	22.5	15.2a
Maximum	2,900	355b	4,909	1,842b	22.6	15.4b

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–12.—*Effect of test variables on neps in card web and ends down in spinning,* 'Stoneville 213' *machine-picked cotton*

Test variable	Neps in card web per 100 in²	Ends down per 1,000 spindle-hours
Replication:[1]		
1	6a	19
2	6a	24
3	7b	21
Number of driers:		
0	[1]6a	[2]14a
1	5b	21b
2	6ab	28c
Number of lint cleaners:[2]		
0	5a	23
1	6b	19
2	7b	22
Mill-cleaning level:[3]		
Minimum	6	22
Maximum	6	21

[1] Means not having a letter in common are significantly different at the 5% level.

[2] Means not having a letter in common are significantly different at the 1% level.

[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–13.—*Effect of test variables on colorimeter results,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Reflectance (R_d)		Degree of yellowness (+b)	
	Ginned lint	Cleaned lint	Ginned lint	Cleaned lint
Replication:[1]				
1	71.1	77.2	7.4a	8.6a
2	70.0	77.2	7.4a	8.1b
3	70.4	76.6	6.9b	7.8c
Number of driers:				
0	[2]69.6a	76.8	[1]7.0a	8.2
1	71.0b	77.1	7.3b	8.2
2	70.9b	77.1	7.4b	8.2
Number of lint cleaners:[1 3]				
0	67.3a	76.6	6.9a	8.3
1	71.4b	77.1	7.3b	8.1
2	72.8c	77.2	7.5c	8.2

[1] Means not having a letter in common are significantly different at the 1% level.

[2] Means not having a letter in common are significantly different at the 5% level.

[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–14.—*Effect of test variables on digital fibrograph results,* 'Stoneville 213' *brush-stripped cotton*

Test variable	2.5% span length (in)		50% span length (in)		Uniformity ratio (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	1.12a	1.17a	0.47a	0.56a	41.7a	47.7a
2	1.13a	1.18a	.47a	.57a	41.4ab	48.9b
3	1.08b	1.14b	.44b	.54b	41.0b	47.4a
Number of driers:						
0	[1]1.12a	[2]1.171a	[1].47a	[1].57a	[1]41.9a	[1]48.8a
1	1.11b	1.166ab	.46b	.56ab	41.4a	47.8ab
2	1.10c	1.156b	.45c	.55b	40.8b	47.3b
Number of lint cleaners:[1]						
0	1.12a	1.16	.47a	.56	42.1a	48.2
1	1.11b	1.16	.46b	.56	41.0b	48.1
2	1.10c	1.17	.45b	.56	41.0b	47.3
Mill-cleaning level:[3]						
Minimum	([4])	1.16	([4])	.56	([4])	48.1
Maximum	([4])	1.16	([4])	.56	([4])	47.9

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.

TABLE A–15.—*Effect of test variables on Pressley strength and micronaire results,* 'Stoneville 213' *brush-stripped cotton*

Test variable	Strength 0-in gage (1,000 lb/in²)		Strength ⅛-in gage (g/tex)		Micronaire	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	84a	80	21.7a	21.5a	4.0a	4.0
2	82b	81	21.9a	21.3a	4.0a	3.9
3	82b	81	21.4b	20.4b	3.9b	3.9
Number of driers:[1]						
0	83	82a	22.0a	21.4a	4.0a	4.0a
1	83	81a	21.6b	21.0b	4.0a	4.0a
2	83	80b	21.4b	20.8b	3.9b	3.9b
Number of lint cleaners:						
0	[2]83ab	81	21.7	20.9	[1]4.0a	3.9
1	82a	81	21.7	21.2	3.9b	3.9
2	84b	81	21.6	21.0	3.9b	4.0
Mill-cleaning level:[3]						
Minimum	([4])	81	([4])	21.1	([4])	3.9
Maximum	([4])	81	([4])	21.1	([4])	3.9

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.

TABLE A–16.—*Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability)*, 'Stoneville 213' *brush-stripped cotton*

Test variable	Upper-quartile length (in)		Mean length (in)		Coefficient of variability (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	1.22a	1.23a	0.97a	0.99a	34a	33a
2	1.21a	1.23a	.96a	.98a	34a	34a
3	1.18b	1.22b	.91b	.95b	37b	35b
Number of driers:[1]						
0	1.23a	1.24a	.98a	.99a	35.6b	33a
1	1.21b	1.22b	.95b	.97b	34.9a	33a
2	1.18c	1.22b	.92c	.96c	36.2c	35b
Number of lint cleaners:[2]						
0	1.21	1.23	.96	.98	34.4a	33
1	1.21	1.23	.95	.97	34.8ab	34
2	1.20	1.22	.94	.97	35.4b	34
Mill-cleaning level:[3]						
Minimum	([4])	([5])	([4])	([5])	([4])	([5])
Maximum	([4])	1.23	([4])	.97	([4])	34

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.
[5] Array data are for those treatments with maximum mill cleaning only.

TABLE A–17.—*Effect of test variables on Suter-Webb array results (fiber lengths)*, 'Stoneville 213' *brush-stripped cotton*

[Percent]

Test variable	Fibers less than ½ in		Fibers ½ to 1 in		Fibers 1 in and longer	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	12.1a	11.9a	32.1a	29.9a	52.7a	57.9a
2	12.7a	12.1a	34.2b	30.4a	47.2b	57.1a
3	15.4b	13.3b	37.0c	32.5b	51.8a	53.8b
Number of driers:[1]						
0	12.1a	11.6a	31.2a	29.2a	56.2a	59.0a
1	13.3a	13.4b	34.7b	31.0b	51.8b	56.3b
2	14.8b	12.4a	37.5c	32.6c	47.4c	53.5c
Number of lint cleaners:						
0	[2]13.1a	12.2	33.9	[1]30.1a	[2]52.5a	[2]57.2a
1	13.0a	12.6	34.0	30.7ab	52.6a	56.4ab
2	14.1b	12.6	35.4	32.0b	50.2b	55.2b
Mill-cleaning level:[3]						
Minimum	([4])	([5])	([4])	([5])	([4])	([5])
Maximum	([4])	12.4	([4])	30.9	([4])	56.3

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.
[5] Array data are for those treatments with maximum mill cleaning only.

TABLE A–18.—*Effect of test variables on colorimeter results,* 'Stoneville 213' *machine-picked cotton*

Test variable	Reflectance (R_d)		Degree of yellowness ($+b$)	
	Ginned lint	Cleaned lint	Ginned lint	Cleaned lint
Replication:				
1	74.9	77.4	[1]8.7a	[2]9.0a
2	73.9	77.7	8.7a	9.2a
3	74.3	78.3	8.5b	9.4b
Number of driers:				
0	74.2	[1]78.4a	[2]8.5a	9.1
1	73.9	76.8b	8.5a	9.2
2	75.0	78.1a	8.8b	9.2
Number of lint cleaners:				
0	[2]73.3a	[1]77.6a	[2]8.4a	[1]9.2ab
1	74.2ab	77.1a	8.7b	9.3a
2	75.6b	78.7b	8.7b	9.1b

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.

TABLE A–19.—*Effect of test variables on digital fibrograph results,* 'Stoneville 213' *machine-picked cotton*

Test variable	2.5% span length (in)		50% span length (in)		Uniformity ratio (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:						
1	1.13	[1]1.17ab	[2]0.48a	[2]0.57a	[1]42.7a	[1]49.1a
2	1.13	1.16a	.49b	.56b	43.7b	48.3b
3	1.14	1.17b	.49b	.56b	43.2ab	48.2b
Number of driers:[1]						
0	1.15a	1.17a	.51a	.58a	44.1a	49.4a
1	1.13b	1.16b	.49b	.56b	42.9b	48.3b
2	1.12b	1.16b	.48b	.55b	42.6b	47.8b
Number of lint cleaners:						
0	[1]1.14a	[2]1.17a	[1].50a	[2].57a	[1]44.0a	[2]48.9a
1	1.13b	1.16b	.49b	.56b	43.1b	48.1b
2	1.12c	1.17ab	.48b	.56ab	42.4c	48.5ab
Mill-cleaning level:[3]						
Minimum	([4])	1.17	([4])	.57	([4])	48.8
Maximum	([4])	1.16	([4])	.56	([4])	48.2

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.

TABLE A–20.—*Effect of test variables on Pressley strength and micronaire results,* 'Stoneville 213' *machine-picked cotton*

Test variable	Strength 0-in gage (1,000 lb/in²)		Strength ⅛-in gage (g/tex)		Micronaire	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	86	82a	22.4a	22.2	4.2	4.2
2	87	83a	21.4b	22.1	4.2	4.2
3	86	80b	21.5b	22.0	4.2	4.3
Number of driers:						
0	[1]87a	82	[1]22.3a	22.3	[2]4.16a	4.2
1	86ab	81	21.5b	22.1	4.22b	4.3
2	86b	82	21.4b	21.9	4.17ab	4.2
Number of lint cleaners:						
0	87	82	21.8	22.3	4.2	4.3
1	86	82	21.7	21.9	4.2	4.2
2	86	82	21.7	22.1	4.2	4.2
Mill-cleaning level:[3]						
Minimum	(4)	82	(4)	22.1	(4)	4.2
Maximum	(4)	82	(4)	22.1	(4)	4.2

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.

TABLE A–21.—*Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability),* 'Stoneville 213' *machine-picked cotton*

Test variable	Upper-quartile length (in)		Mean length (in)		Coefficient of variability (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:						
1	[1]1.23a	1.27	[2]0.97a	[1]1.02a	[2]35a	31
2	1.23a	1.25	.98ab	1.00b	34b	32
3	1.24b	1.26	.99b	1.02ab	33b	31
Number of driers:[2]						
0	1.25a	1.27a	1.00a	1.04a	33a	30a
1	1.23b	1.26ab	.98b	1.01b	34a	32b
2	1.23b	1.25b	.96b	.99b	35b	33b
Number of lint cleaners:[2]						
0	1.24a	1.26	.98a	1.02	34	31
1	1.24a	1.26	.98a	1.01	34	32
.....	1.23b	1.26	.97b	1.01	34	32
ng level:[3]						
----	(4)	(5)	(4)	(5)	(4)	(5)
.....	(4)	1.26	(4)	1.02	(4)	32

[1] g a letter in common are significantly different at the 5% level.
[2] g a letter in common are significantly different at the 1% level.
[3] of minimum and maximum, see table 1, notes 4 and 5.

[5] or those treatments with maximum mill cleaning only.

TABLE A–22.—*Effect of test variables on Suter-Webb array results (fiber lengths), 'Stoneville 213' machine-picked cotton*

[Percent]

Test variable	Fibers less than ½ in		Fibers ½ to 1 in		Fibers 1 in and longer	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:						
1	[1]12.9a	9.8	32.0	27.1	[2]54.7a	62.8
2	12.0ab	10.9	31.9	28.4	55.8ab	60.3
3	11.7b	9.8	31.0	28.0	56.9b	61.7
Number of driers:[1]						
0	11.3a	8.7a	30.4a	25.6a	57.8a	65.3a
1	12.0a	10.4b	31.9ab	28.0b	55.7ab	61.1b
2	13.1b	11.3b	32.5b	29.8b	53.9b	58.4b
Number of lint cleaners:[1]						
0	11.9	9.8	30.7a	26.9	56.9a	63.0
1	12.1	10.2	31.0a	28.2	56.6a	61.1
2	12.4	10.4	33.1b	28.3	53.9b	60.7
Mill-cleaning level:[3]						
Minimum	([4])	([5])	([4])	([5])	([4])	([5])
Maximum	([4])	10.2	([4])	27.8	([4])	61.6

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.
[5] Array data are for those treatments with maximum mill cleaning only.

TABLE A–23.—*Effect of test variables on colorimeter results, 'Acala 1517–V' machine-picked cotton*

Test variable	Reflectance (R_d)		Degree of yellowness ($+b$)	
	Ginned lint	Cleaned lint	Ginned lint	Cleaned lint
Replication:				
1	[1]75.4a	[1]78.7a	[2]7.1a	7.8
2	74.1ab	77.0b	7.3b	7.8
3	72.9b	76.9b	7.3b	7.8
Seed-cotton-cleaning level:				
Bypass overhead	[1]73.0a	[1]76.7a	[2]7.2a	7.8
Through overhead	75.3b	78.4b	7.3b	7.9
Number of lint cleaners:[1]				
0	70.2a	75.6a	7.0a	7.7a
1	75.1b	78.3b	7.2b	7.9b
2	77.2c	78.7b	7.5c	7.7a

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.

TABLE A–24.—*Effect of test variables on digital fibrograph results,* 'Acala 1517–V' *machine-picked cotton*

Test variable	2.5% span length (in)		50% span length (in)		Uniformity ratio (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	1.21a	1.25a	0.54	0.68	45a	55
2	1.21a	1.25a	.54	.68	45a	55
3	1.19b	1.27b	.55	.69	46b	54
Seed-cotton-cleaning level:[2]						
Bypass overhead	1.20a	1.25	.54	.68	45	54
Through overhead	1.21b	1.26	.54	.69	45	55
Number of lint cleaners:						
0	[2]1.207a	1.26	[1].56a	.68	[1]46a	54
1	1.203ab	1.25	.54b	.68	45b	54
2	1.198b	1.26	.53b	.69	44c	55
Mill-cleaning level:[3]						
Minimum	1.20	1.26	.54	[2].69a	45	55
Maximum	1.20	1.25	.54	.68b	45	54

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–25.—*Effect of test variables on Pressley strength and micronaire results,* 'Acala 1517–V' *machine-picked cotton*

Test variable	Strength 0 in gage (1,000 lb/in²)		Strength ⅛ in gage (g/tex)		Micronaire	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:						
1	[1]93a	[1]88a	[2]26.5a	[1]26.3a	3.8	3.9
2	91b	85b	26.8ab	26.7b	3.8	3.9
3	91b	86b	27.3b	26.5a	3.8	3.9
Seed-cotton-cleaning level:[2]						
Bypass overhead	92a	86	26.8	26.4a	3.8	3.9
Through overhead	91b	86	27.0	26.6b	3.8	3.9
Number of lint cleaners:						
0	[1]90a	87	[2]27.2a	[1]26.5ab	[1]3.8a	3.9
1	92b	87	26.9ab	26.7a	3.7b	3.9
2	93b	86	26.5b	26.3b	3.7b	3.9
Mill-cleaning level:[3]						
Minimum	92	86	26.9	26.5	3.8	3.9
Maximum	92	86	26.9	26.5	3.8	3.9

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.

TABLE A–26.—*Effect of test variables on Suter-Webb array results (upper-quartile length, mean length, and coefficient of variability), 'Acala 1517–V' machine-picked cotton*

Test variable	Upper-quartile length (in)		Mean length (in)		Coefficient of variability (%)	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:						
1	[1]1.32a	1.34	1.10	[2]1.15a	28	[2]24a
2	1.32a	1.34	1.10	1.14ab	28	24a
3	1.33b	1.34	1.10	1.13b	29	25b
Seed-cotton-cleaning level:						
Bypass overhead	1.32	1.34	1.10	1.14	28	24
Through overhead	1.33	1.33	1.10	1.13	28	24
Number of lint cleaners:						
0	1.32	1.33	1.10	1.14	28	24
1	1.33	1.34	1.11	1.14	29	24
2	1.32	1.34	1.10	1.14	28	24
Mill-cleaning level:[3]						
Minimum	([4])	([5])	([4])	([5])	([4])	([5])
Maximum	([4])	1.34	([4])	1.14	([4])	24

[1] Means not having a letter in common are significantly different at the 5% level.
[2] Means not having a letter in common are significantly different at the 1% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.
[5] Array data are for those treatments with maximum mill cleaning only.

TABLE A–27.—*Effect of test variables on Suter-Webb array results (fiber lengths), 'Acala 1517–V' machine-picked cotton*

[Percent]

Test variable	Fibers less than ½ in		Fibers ½ to 1 in		Fibers 1 in and longer	
	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing	Ginned lint	Finisher drawing
Replication:[1]						
1	7.0ab	3.3a	20.3	20.1a	72.6	76.3a
2	6.5b	3.0a	20.5	21.1ab	72.6	75.3ab
3	7.3a	4.2b	20.9	21.9b	71.5	73.6b
Seed-cotton-cleaning level:[1]						
Bypass overhead	7.0	3.7a	20.4	20.6	72.3	75.5
Through overhead	6.9	3.3b	20.6	21.5	72.1	74.6
Number of lint cleaners:[2]						
0	6.9	3.5ab	20.0	21.4	72.9	74.7
1	7.0	3.3b	20.6	20.7	72.0	75.8
2	7.0	3.7a	20.8	21.0	71.9	74.8
Mill-cleaning level:[3]						
Minimum	([4])	([5])	([4])	([5])	([4])	([5])
Maximum	([4])	3.5	([4])	21.0	([4])	75.1

[1] Means not having a letter in common are significantly different at the 1% level.
[2] Means not having a letter in common are significantly different at the 5% level.
[3] For explanation of minimum and maximum, see table 1, notes 4 and 5.
[4] Not applicable.
[5] Array data are for those treatments with maximum mill cleaning only.

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